IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT

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In re Application of:	LUNDSTROM, Dennis *et al.*	Group Art Unit:	1725
Serial No.:	10/707,185	Confirmation No.	1184
Date Filed:	November 25, 2003	Examiner:	JOHNSON, Jonathan J.

For: METHOD OF TYING TWO OR MORE COMPONENTS TOGETHER

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

Dear Sir:

In compliance with Rules 1.97 and 1.98, it is respectfully requested that the references listed on the accompanying enclosed Form SB/08a be made of record and considered with respect to the above-referenced U.S. patent application. A copy of each reference is enclosed.

Referring to US Patents Cite No. 1, US 5,116,691, the state-of-the-art character of intermetallic compounds (intermetallics) is described at column 1, lines 35-48 as follows:

> Intermetallic compounds, frequently referred to simply as intermetallics, are compounds of metals having particular crystal structures which are different from those of the component metals. Intermetallics have ordered atom distribution. Although the bonding of intermetallics is still predominantly metallic bonding, making them less brittle than ceramics, they still tend to be brittle at ambient temperature. These ordered structures exist over specific composition ranges and exhibit high melting points while having the potential for good strength, despite having low ductilities or fracture toughnesses at ambient temperature. Typical intermetallics include TiAl, Ti_3Al, Ni_3Al and NiAl.

Referring to Non-Patent Literature Cite No. 1, ORDERED INTERMETALLICS, certain basically accepted characteristics of intermatallics are defined in the Introduction section that reads:

> ORDERED INTERMETALLICS
>
> *Introduction*
>
> For the past 15 years, considerable effort has been devoted to the study of ordered intermetallics, a unique class of metallic materials that form long-range ordered crystal structures below a critical temperature in the solid state. Some of these ordered intermetallics, especially those based on aluminides and silicides, possess many attractive properties for structural use at elevated temperatures in hostile environments (1–13). In general, the aluminides and silicides contain sufficient amounts of aluminum and
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silicon to form, in oxidizing environments, oxide scales that are often compact and protective. These intermetallics have relatively low density, high melting points, good thermal conductivity, and superb high-temperature strength. Many intermetallics also show a yield strength anomaly (14–16), that is, their strength increases rather than decreases with temperature. As a result, these intermetallics are particularly suited for structural applications at elevated temperatures.

Still further, the unique and well understood special characteristics of intermatallics are further described in Non-Patent Literature Cite No. 2, INTERMATALLIC PHASES - MATERIALS DEVELOPMENTS AND PROSPECTS, where the following is explained:

1 Introduction

Since several years there is a renewed and pronounced interest in intermetallic phases with respect to materials developments for high-temperature applications[1]). [redacted] These structures form because there is a very strong bonding of the unlike atoms, and from this strong bonding particular physical and mechanical properties result. Intermetallic phases had been in use for various purposes since many centuries because of their comparitively high hardness (Table 1 a), whereas in modern times their particular physical properties have been of primary interest (Table 1b).

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view [redacted] and thus the develop-

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Figure 4 shows a recent version of the Ti-Al phase diagram which is still in discussion in particular with respect to Ti_3Al. The phases on which materials developments have been based are Ti_3Al with DO_{19} structure (ordered close-packed hexagonal) and TiAl with $L1_0$ structure (tetragonally distorted ordered fcc). Table 2 shows some characteristic properties of these phases in comparison with conventional Ti alloys and superalloys. The two titanium aluminides com-

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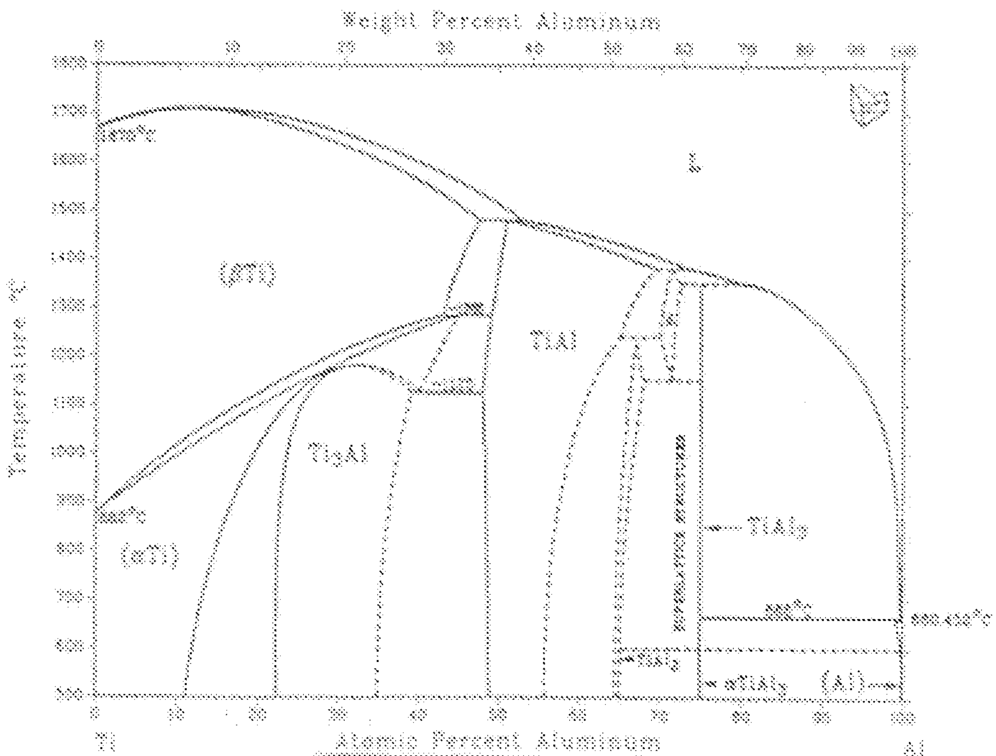

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Table 2. Characteristic properties of Ti_3Al, TiAl, Ti alloys and superalloys[18].

	Ti alloys	Ti_3Al	TiAl	super-alloys
density (Mg/m^3)	4.5	4.15~4.7	3.76	8.3
Young's modulus (GN/m^2)	110~96	145~110	176	206
max. temp. (°C)				
creep	540	815	1040	1090
oxidation	590	650	1040	1090
ductility (%)				
room temperature	~ 20	2~5	1~2	3~8
service	high	5~8	7~12	10~20

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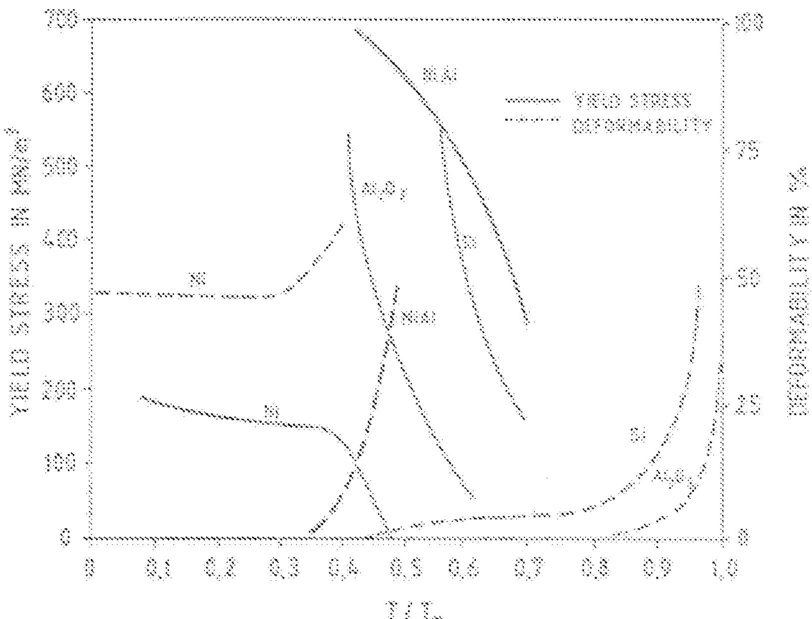
[redacted] intermetallic NiAl which is a candidate phase for high-temperature applications softens with rising temperature at about half the melting point



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The benefits, as well as challenges associated with working with intermatallics are also appreciated by those skilled in the art as described in Non-Patent Literature Cite No. 3, MATERIALS - INTERMATALLIC, in which the following is disclosed:

MATERIALS

Intermetallics

Anthony F. Giamei, FASM (1977)

Intermetallic compounds and alloys have great potential in structural engineering applications, especially at high temperatures. Among the characteristics that make intermetallics so interesting is oxidation resistance at temperatures exceeding 1,100°C (2,000°F). Unfortunately, they also have some serious limitations.

Consequently, through the 1990s, researchers will be seeking ways to improve certain intermetallic properties, especially high-temperature characteristics including ductility

large Burger's vector, or a low solubility of interstitial or trace elements, leading to immobile dislocations or the formation of embrittled grain boundaries.

[redacted] Also, creep strength should be considered on a density-corrected basis. These characteristics make some of the intermetallics exciting candidates for future high-temperature structural use

[redacted] The same strong bonding that makes the materials ordered and strong makes them brittle. Low ductility at low-to-intermediate

The well known characteristics of intermatallics are further described in Non-Patent Literature Cite No. 4, THE PROMISE OF INTERMATALLIC, in which the following is disclosed:

The Promise of Intermetallics

Intermetallics offer the high strength at high temperatures, low density, and high stiffness required for the National Aerospace Plane, interstellar travel, improved diesel engines, and processing equipment for the oil, coal, and chemical industries.

Margaret Hunt
Associate Editor

Intermetallic compounds are well known as constituents of superalloys: Nickel-based superalloys derive much of their high-temperature strength from nickel aluminides and nickel sil-

high stiffness, low density, and high resistance to oxidation and sulfidation. [redacted] However,

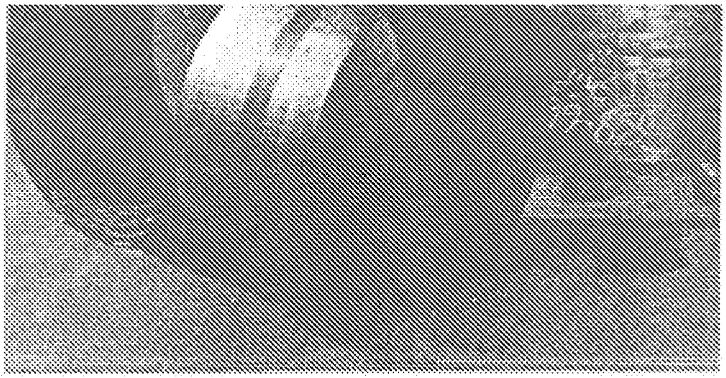
[redacted]

Most pure metals have crystal structures such as face centered cubic (fcc), body centered cubic (bcc), or hexagonal close-packed (hcp). In fcc structures, for example, an atom occupies each corner of the cubic structure and the center of each face.

As alloying metals with atoms of similar size are added, they randomly replace the original atoms. For example, as aluminum atoms are added to fcc nickel, they may occupy either corners or face positions.

In some alloys, as the alloying additions reach a critical number of atoms, they begin to occupy specific positions. For example, [redacted]

The reason for this order is the [redacted] The requirement for the nearest neighbor of each aluminum atom to be a nickel atom results in the ordered structure. Because this order is maintained throughout the bulk of the material, [redacted] is



[redacted] but three predominate. First, flow stress can be higher than cleavage stress in the slip planes. For example, the pressure required to cause one cube to slide past another can be higher than that required to break the bonds between the cubes. [redacted]

Second, some lattice structures are so large and complicated that they cannot deform without breaking. Alloying additions have helped in some cases where the original lattice is modified to a more ductile structure. For example, Co_3V has a brittle hcp structure. Iron in large amounts (up to 30 at.%) was added by researchers at Oak Ridge National Laboratory, Oak Ridge, TN, and the structure changed to fcc with room temperature elongation of 40%. With small additions of aluminum for oxidation resistance, this intermetallic has the potential for use as high-speed brake material.

[redacted] Micro-alloying additions that segregate to grain boundaries and strengthen them have been successful in some cases. For example, researchers at Oak Ridge found that boron additions of 100 to 1000 ppm raise tensile elongation of Ni_3Al from essentially nothing to as high as 50%.

Titanium Aluminides for Aerospace

Aluminum is attractive as an intermetallic alloying element because it has low density, and because it forms tenacious coatings of aluminum oxide that provide protection at high temperatures. Aluminides of titanium may be useful for skin and structural components of the National Aerospace Plane (NASP) and other aerospace applications because of their low density and high-temperature capability. They include alpha titanium (Ti_3Al), gamma (TiAl), and several compositions that are variations of these compounds. For example, alpha-2 Ti_3Al has a general composition Ti-14Al-21Nb, with niobium added to improve ductility and fracture toughness. Super

Properties of Selected Intermetallics

Alloy	Crystal structure (ordered)	Melting point (°F)	Density (g/cc)	Young's modulus (10^6 psi)
Ni_3Al	face-centered cubic	2530	7.50	25.9
NiAl	body-centered cubic	2985	5.86	42.7
Fe_3Al	body-centered cubic	2800	6.72	20.4
FeAl	body-centered cubic	2250	5.56	[illegible]
Ti_3Al	hexagonal close packed	2910	4.20	[illegible]
TiAl	tetragonal	2640	3.91	25.5
[illegible]	rhombohedral	3100	[illegible]	[illegible]

Data courtesy Oak Ridge National Laboratory and Brush Wellman.

In view of the disclosures of the included documents and the discussion above, it is readily apparent that the Office's abbreviated definition of *intermatallic* as being "composed of two or more metals or of a metal and non-metal" is not the definition that is applied by those persons skilled in the relevant art; further, the oversimplification at paragraph 9 of the Action dated 15 September 2006 is inaccurate - - the term "intermatallic" connotes far more than merely being "two or more metals" as defined and explained hereinabove.

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Applicants reserve the right to establish the patentability of the claimed invention over any of the information provided herewith, and/or to prove that this information may not be prior art, and/or to prove that this information may not be enabling for the teachings purportedly offered.

The filing of this information disclosure statement shall not be construed as a representation that a search has been made, or an admission that the information cited is, or is considered to be, material to patentability, or that the information is analogous to the subject matter of the present invention, or that no other material information exists. Further, the filing of this information disclosure statement shall not be construed as an admission against interest in any manner. Written notification that the enclosed references have been considered in their entirety by return of a copy of the enclosed form, completed by the Examiner, is respectfully requested.

This Information Disclosure Statement is being submitted after the mailing of a non-final Office Action, but is believed to be prior to a final Office Action or a Notice of Allowance. Pursuant to 37 C.F.R. § 1.97(c)(2), the $180.00 fee is being paid herewith. In the event any variance exists between the amount enclosed and the Patent Office charges, please charge or credit any difference to the undersigned's Deposit Account No. 14-1437.

In order to facilitate the resolution of any issues or questions presented by this paper, the Examiner may directly contact the undersigned by phone to further the discussion.

Respectfully submitted,

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